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A Case of Conspicuous Sexual Difference in Coloration in Stomatopod, with Notes of a Male with Coloration approaching that of the Female.

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With 2 Text-figures.

I. Conspicuous sexual difference in coloration in a stomatopod.

In the crustacea the coloration is generally alike in both the male and female and only a few instances of conspicuous sexual color differences have so far been known. Andrews[1] mentions four recorded cases and another of his own. Of these five cases, one concerns with a stomatopod, "*Squilla stylifera*."[2] It may be noted that this case is also referred to by Darwin in "The Descent of Man," p. 416.[3] The original observation was made by Clark at Mauritius and its account is found in a paper read by Fraser before a meeting of the London Zoological Society (*Proc. Zool. Soc. London*, 1869, p. 3). Clark states that, "When first hatched the larvae are of a delicate yellowish green, and are very active. As they grow they assume a mottled grey, and the swimmerets and legs become pea-green. The green gradually increases in brightness, but it is not till they have reached a length of three inches that the colours of the adult appear. The male is then of a beautiful bluish green, with the jaw-feet, the swimmerets, and the branchiae as well as the antennae and the fimbriae which border the different organs, of cherry-red. The female is clouded with brown and grey, presenting much the appearance of tortoise shell, and the red about her is much less vivid than in the male." Undoubtedly this is the only record of conspicuous color difference existing between the sexes of the stomatopoda.

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[1] *Zool. Anz.*, 1911, 38 401–403.

[2] According to Miers, 1880, *Ann. Mag. Nat. Hist.*, 5, V, "*Squilla stylifera*" here recorded should be referred to *Pseudosquilla ciliata* (Fabr.). This view has generally been accepted by most of recent writers.

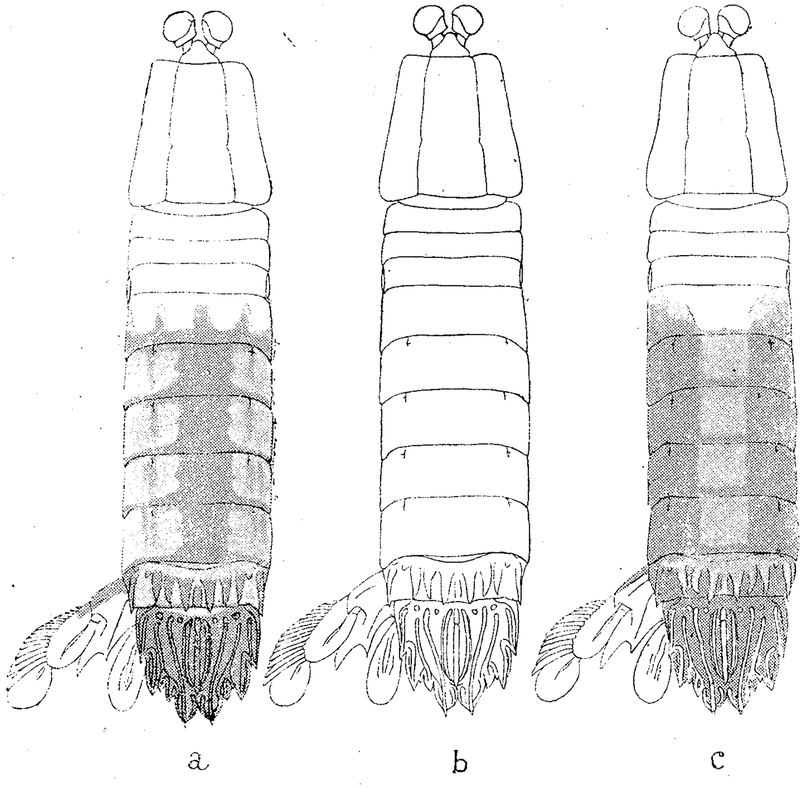
[3] One volume edition (John Murray).

The present note deals with a new case of the same kind found in a stomatopod, *Odontodactylus japonicus* (De Haan). This inhabits warmer parts of the Japanese coast in the range of the " Black-stream " and belongs to rather commoner forms of this group known from the Japanese waters. I have thus far examined specimens of this species obtained from the Gulf of Tokyo, the Tateyama Bay of Prov. Awa, the Sagami Sea, the Bonin Islands and Nagasaki. Outside of the Japanese coast the form has been recorded from Hong-kong, the Chinese Seas and off the Seychelles. In the neighbourhood of Misaki it is captured from time to time in fishermen's nets and is known among the natives as "Hana-syako" which means " flower mantis-shrimp." This is because both the sexes of the form are colored very bright.

In the male, the entire dorsal surface of the body is of a bright salmon-red color. The color is shaded into a vivid purple in the antennal scales as well as in both the exo- and endopodites of the uropods. The marginal hairs of these appendages are all of very bright scarlet-red. The mobile spines of the exopodite are orange. In the female, on the other hand, the posterior half of the body is bluish green; the color is shaded into the salmon-red of the anterior half of the body at the first abdominal somite. Text-figure 1, a illustrates the distribution of the two colors, the shades in the figure representing the bluish-green color in the body. The salmon-red color of the anterior half of the body is not so bright as in the male. For the rest, the coloration of the sexes is practically identical. The difference in the coloration of the sexes is so remarkable that one can readily tell one from the other without examining structural differences, provided the specimens be fresh or shortly in preserving fluid.

II. Notes on a male with coloration approaching that of the female.

A male individual of *Odontodactylus japonicus* (De Hann), 128 mm. in length, was captured at Misaki on October 22, 1917. Its coloration, examined when still alive, showed some difference from that of the ordinary male. being shaded with distinct bluish-green in the lateral parts of the abdominal somites (Textfigure 1, c). The middle region of



Text-figure 1.

Text-figure 1. Distribution of the salmon-red (unshaded parts) and the bluish-green (shaded parts) colors, in normal female (a), normal male (b) and in the abnormal male specimen (c). ×$\frac{2}{3}$.

those somites was colored salmon-red similarly to the ordinary males, but the bluish-green of the lateral parts was so striking that the coloration of that individual approached to a considerable extent to that of the female. Indeed one may be quite justified to state that, the coloration of that individual was just intermediate between those of two sexes.

To see if the abnormality in coloration might be associated with some internal abnormality, the specimen was dissected. My attention was attracted at once to an abnormal condition of the internal structures of the posterior part of the body (Textfigure 2, a). In the telson the hepatic organ (he), which ordinarily fills up the entire cavity, occupied but a small part in the antero-lateral region on the right side; the pair of powerful muscles (m), which are situated in the anterior region of the telson on either side of the intestinal tube, had considerably been reduced in size. The reduction was especially marked on the left side where the muscle was no more than one-tenth the original size. Moreover, of the four or five pairs of ligaments (lg) situated between those muscles and the intestinal tube, there remained but two anterior pairs, which were all much more slender than normal especially on the left side. Above all, attention was called to the condition of the testes. In the normal male of the stomatopoda the testes form a very slender convoluted filiform structure paired in the greater part of the length and unpaired in the posterior terminal part; the posterior end of the organ attains nearly the level of the base of the intermediate marginal spines of the telson.[1] In the specimen under consideration, however, the testes terminated bluntly in the fifth abdominal somite, the parts occurring ordinarily in the two succeeding somites being absent. In all other respects, the internal structure of that specimen seemed to be quite normal. The examination of the sections of the testes revealed quite numerous sperms. The problematical "accessory glands," which are generally assumed to belong

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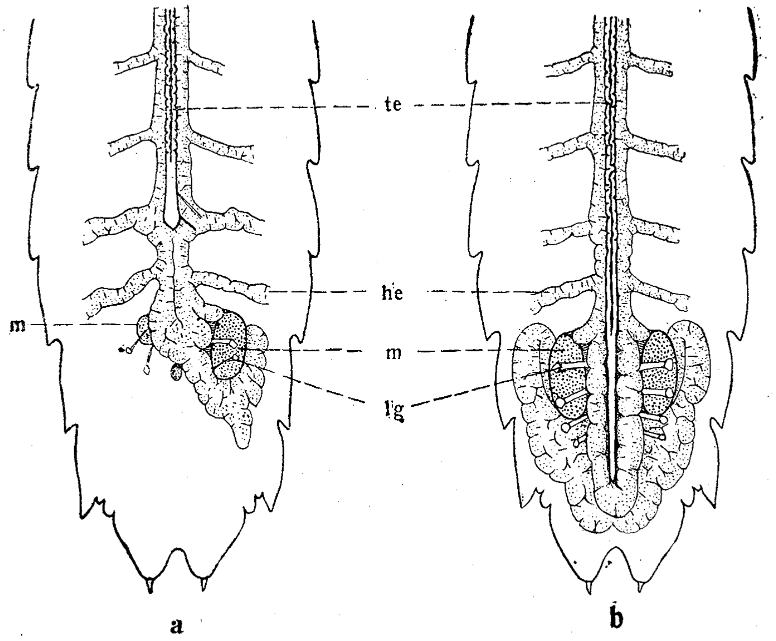
[1] For details of the structure of the male gonad of the stomatopoda, see Grobben, 1876, *Sitz. k. Acad. Wiss. Mathem.-Naturw. Klass.*, 74, 389–406.

to the reproductive system and which occur in the exposed thoracic somites, were found to be quite normal. The same was true for all external structural features. *Odontodactylus japonicus* shows, as in all other members of the order, sexual differences in certain parts of its external structure. Firstly, the male has a tubular penis attached to the basal segment of each ambulatory leg of the eighth thoracic somite, whereas the female genital opening exists on the mid-ventral line of the sixth thoracic somite. Secondly, the distal parts of the endopodite of the first pair of pleopods are modified, only in the male, to form a fairly complicated structure apparently functional during copulation. And thirdly, the terminal segment of the exopodite of the second pair of pleopods is provided, in the male alone, with a longitudinal ridge.[1] The male in-



Text-figure 2.

Text-figure 2. Posterior portions of soft parts in the abnormal male specimen (a) compared with those of normal male (b), somewhat schematized: *he* hepatic organ; *lg*, ligaments; *m*, muscles; *te*, testes. ×1.

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[1] For further details, see Giesbrecht, 1910, *Fauna u. Flora d. Golf v. Neapel, Monogr.* 33, *p.* 21 *et seq.*

dividual under consideration showed no deviation from these sexual characteristics.

In view of the facts described above, concerning the abnormal individual, it is rather natural to assume the existence of some relation between the defective development of the hepatic organ, testes and others on one side and the abnormal coloration on the other. Here the primary cause of all the abnormalities remains unknown. But it is quite possible that the abnormal coloration was produced unter the influence of an abnormal physiological condition that had been brought about by the imperfect development of the structures in the terminal part of the body. Question naturally arises, why the abnormal physiological condition had its influence only upon the coloration and not upon any of those external structural features. To give answer to this question, it seems neccessary to take essentially the same view expressed by Korrhauser[1] a propose the change of male sexual characteristics of a membracid induced by a parasitic hymenopteron. The differences in structure between the sexes of the stomatopoda seem to be of a more fundamental nature. They are established in the development of the animal quite early, as soon as it abandons pelagic life and enters littoral stage. Thus Giesbrecht[2] mentions that, the males of stomatopods in the first littoral stage are already provided with the penis on their last ambulatory legs, and the peculiar structure in the first pair of pleopods should develop somewhat later. The coloration characteristic of the sexes, on the other hand, seems to be established in a much later stage, as shown in the above description quoted from *Proc. Zool. Soc. London*, 1869. Not only ontogenetically, but phylogenetically as well, the sexual coloration seems to have developed quite recently. This may be inferred from the fact that the instances of this kind are very rare in the stomatopada. Consequently the coloration seems to remain still in a rather unstable condition, so that even a slight anomaly in physiological condition may exert some influence so as to check its completion. The case is, however, may be entirely different with regard to those external structures, which, being, both phylogenetically and ontogenetically, of a much older origin, are in a state of much greater stability, so that even a considerable change in physiological condition is not able to affect their development. This assumption is also supported by my observation some years ago upon a male specimen of *Squilla oratoria* De Haan ; it has been infested very heavily by a peculiar rhizocephalan, *Thompsonia japonica* Haefele, yet it did not show even the slightest abnormality in any of those sexual features.

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[1] 1919, *Jour. Morph.*, 34, 307-333.

[2] *Opt. cit.*, *p.* 1-49.

The above-mentioned case of the change in the sexual feature of the stomatopod reminds one of the well-known case of *Inachus* infested by *Sacculina*. In both cases the sexual character of the male alone is affected and approaches that of the female. In accounting for the transformation of the parasitized male crab, most recent writers maintain that the change of metabolism toward that of the female induced by the parasite should play an important part. But, in the case under consideration the effect of a parasite is probably to be eliminated, and we have no ground to postulate the affinity of the metabolism of that individual to that of the female. The present observation thus apparently throws doubt on the validity of the interpretation of those authors.